IN THE MATTER OF
Patent Application of
HONDA MOTOR CO., LTD.

I, Nobuko SUDA, 17-23 Fukasawa 6-chome, Setagaya-ku, Tokyo 158-0081, Japan, do hereby declare that I am conversant with the Japanese and English languages and am a competent translator thereof. I further declare that to the best of my knowledge and belief, the following is a true and correct translation, made by me, of the official copy of the document in respect of a Patent Application No. 2003-061976 filed in Japan on March 7, 2003.

Signed this 3rd day of July, 2007

By N S Suda
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(Translation)

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[TITLE OF THE INVENTION]

FUEL CELL AND METHOD OF PRODUCING THE SAME

[CLAIMS]

[Claim 1]

A fuel cell comprising:

a porous insulating film;

a plurality of power generation units including a pair of adjacent power generation units, said power generation units each including a anode facing said porous insulating film, a cathode, and an electrolyte interposed between said anode and said cathode;

a first electrically conductive film electrically connected to said anode of one of said adjacent power generation units, and extending in parallel to said anode; and

a second electrically conductive film electrically connected to said cathode of the other of said adjacent power generation units, and extending in parallel to said cathode,

wherein said first electrically conductive film or said second electrically conductive film has an expansion at a position spaced from said electrolyte for connecting said first electrically conductive film and said second electrically conductive film.

[Claim 2]

A fuel cell according to claim 1, wherein said first electrically conductive film is arranged in a substantially same plane with a gas diffusion layer of said anode, and said second electrically conductive film is arranged in a substantially same plane with a gas diffusion layer of said cathode.

[Claim 3]

A fuel cell according to claim 1 or 2, wherein said first electrically conductive film is made of metal, and said second electrically conductive film is made of composite material of resin and electrically conductive material.

[Claim 4]

A fuel cell according to claim 1 or 2, wherein said first electrically conductive film is made of composite material of resin and electrically conductive material, and said second electrically conductive film is made of metal.

[Claim 5]

A method of producing a fuel cell including a plurality of power generation units arranged in a same plane, said power generation units each including electrodes, and an electrolyte interposed between said electrodes, said power generation units including a first power generation unit and a second power generation unit adjacent to said first power generation unit, said method comprising the steps of:

attaching a first electrically conductive film on a porous electrically conductive film;

providing one of said electrode of said first power generation unit and said one of said electrode of said second power generation unit;

electrically connecting said one of said electrode of said second power generation unit and said first electrically conductive film;

providing a first electrolyte on said one of said electrode of said first power generation unit and providing a second electrolyte on said one of said electrode of said second power generation unit such that said first and second electrolytes are partially overlapped on said first electrically conductive film;

providing another of said electrode of said first power generation unit and the other of said electrode of said second power generation unit on said first and second electrolytes, respectively;

electrically connecting said cathode of said first power generation unit and said first electrically conductive film through said second electrically conductive film; and

providing a resin insulator on said second electrically conductive film, and in a gap between said second electrically conductive film and the other of said electrode.

[Claim 6]

A method according to claim 5, further comprising the steps of:

electrically connecting a gas diffusion layer of said

one of said electrode of said second power generation unit and said first electrically conductive film; and

electrically connecting a gas diffusion layer of the other of said electrode of said first power generation unit and said second electrically conductive film for electrically connecting the other of said electrode of said first power generation unit and said one of said electrode of said second power generation unit.

[DETAILED EXPLANATION OF THE INVENTION]

[0001]

[TECHNICAL FIELD TO WHICH THE INVENTION PERTAINS]

The present invention relates to a fuel cell having a plurality of power generation units arranged in a same plane. Each of the power generation units includes an anode, a cathode, and an electrolyte interposed between the anode and the cathode. Further, the present invention relates to a method of producing the fuel cell.

[0002]

[PRIOR ART]

For example, a solid polymer electrolyte fuel cell employs a membrane electrode assembly (MEA) which includes two electrodes (anode and cathode), and an electrolyte membrane interposed between the electrodes. Each of the electrodes comprises an electrode catalyst layer of noble metal supported on a carbon base material. The electrolyte membrane is a polymer ion exchange membrane (cation exchange membrane). The membrane electrode assembly is a power

generation unit interposed between separators (bipolar plates). The membrane electrode assembly and the separators make up a unit of a fuel cell (unit cell) for generating electricity. A predetermined number of the fuel cells are stacked together to form a fuel cell stack.

[0003]

In the fuel cell, a fuel gas (reactant gas) such as a gas chiefly containing hydrogen (hydrogen-containing gas) is supplied to the anode. The catalyst of the anode induces a chemical reaction of the fuel gas to split the hydrogen molecule into hydrogen ions (protons) and electrons. The hydrogen ions move toward the cathode through the electrolyte, and the electrons flow through an external circuit to the cathode, creating a DC electric current. A gas chiefly containing oxygen (oxygen-containing gas) or air is supplied to the cathode. At the cathode, the hydrogen ions from the anode combine with the electrons and oxygen to produce water.

[0004]

For example, Patent Document 1 discloses another flat fuel cell in which a plurality of unit cells are arranged in the same plane in a single row, or a plurality of rows. The unit cells are electrically connected in series. FIG. 15 shows the flat fuel cell. The flat fuel cell includes unit cells 4a through 4d. Air electrodes (cathodes) 2a through 2d and fuel electrodes (anodes) 3a through 3d are provided on both sides of electrolyte layers 1a through 1d. The same

electrodes are arranged on the same side of the electrolyte layers 1a through 1d, i.e., the cathodes 2a through 2d are arranged on one side of the electrolyte layers 1a through 1d, and the anodes 3a through 3d are arranged on the other side of the electrolyte layers 1a through 1d. Conductive Z-like connection plates 5a through 5d connect the unit cells 4a through 4d together in series.

[0005]

Specifically, the conductive Z-like connection plate 5a connects the cathode 2a of the unit cell 4a and the anode 3b of the unit cell 4b, the conductive Z-like connection plate 5b connects the cathode 2b of the unit cell 4b and the anode 3c of the unit cell 4c, and the conductive Z-like connection plate 5c connects the cathode 2c of the unit cell 4c and the anode 3d of the unit cell 4d. The anode 3a of the unit cell 4a is connected to a terminal 6a, and the cathode 2d of the unit cell 3d is connected to a terminal 6b.

[0006]

[Patent Document]

Japanese Laid-Open Patent Publication No. 2002-56855 (FIG. 1)

[0007]

[TASK TO BE SOLVED BY THE INVENTION]

According to the technique disclosed in Patent Document 1, the dedicated Z-like connection plates 5a through 5c are required for connecting the cathodes 2a through 2d and the anodes 3a through 3d of the unit cells 4a through 4d

electrically in series. The Z-like connection plates 5a through 5c extend between the cathodes 2a through 2d and the anodes 3a through 3d, respectively. In this structure, the reliable sealing performance between the cathodes 2a through 2d and the anodes 3a through 3d may not be achieved.

[0008]

Moreover, the thickness of the fuel cell in the direction indicated by an arrow T is large. Thus, the overall size of the fuel cell is not small. Further, the unit cells 4a through 4d are separate components. Therefore, the unit cells 4a through 4d may not be positioned accurately in alignment with each other.

[0009]

In view of the above problems, a general object of the present invention is to provide a fuel cell having a simple and compact structure and a method of producing the fuel cell in which a plurality of power generation units are electrically connected in series for achieving a desired level of voltage, and the power generation units are sealed desirably.

[0010]

[SOLUTION FOR THE TASK]

According to the fuel cell recited in claim 1 of present invention, a plurality of power generation units including a pair of adjacent power generation units are arranged on a porous insulating film. Each of the power generation units includes an anode facing the porous

insulating film and a cathode, and an electrolyte interposed between the anode and the cathode.

[0011]

A first electrically conductive film is electrically connected to the anode of one of the adjacent power generation units, and a second electrically conductive film is electrically connected to the cathode of the other of the adjacent power generation units. The first electrically conductive film or the second electrically conductive film has an expansion at a position spaced from the electrolyte for connecting the first electrically conductive film and the second electrically conductive film.

[0012]

In the adjacent power generation units, the anode of one of the adjacent power generation units is connected to the cathode of the other of the adjacent power generation units by the first and second electrically conductive films. The power generation units of the fuel cell are connected in series using the connection structure.

[0013]

Specifically, assuming that a first power generation unit is disposed adjacent to a second power generation unit, the first electrically conductive film is electrically connected to the anode of the first power generation unit, and the second electrically conductive film is electrically connected to the cathode of the second power generation unit. The first electrically conductive film and the second

electrically conductive film are electrically connected with each other. Thus, the first power generation unit and the second power generation unit are electrically connected with each other.

[0014]

Likewise, the first electrically conductive film connected to the anode of the second power generation unit is connected to the second electrically conductive film connected to the cathode of a third power generation unit which is disposed adjacent to the second power generation unit. Thus, the second power generation unit is electrically connected to the third power generation unit. In this manner, the first through third power generation units are electrically connected in series.

[0015]

Unlike the conventional structure, no dedicated Z-like connection plates are required for electrical connection. The fuel cell is produced at a low cost, and the reliable sealing performance can be achieved. The overall size of the fuel cell is small, and the overall structure of the fuel cell is simple.

[0016]

Preferably, according to the fuel cell recited in claim 2 of the present invention, the first electrically conductive film is arranged in a substantially same plane with a anode diffusion layer of the anode, and the second electrically conductive film is arranged in a substantially

same plane with a cathode diffusion layer of the cathode to reduce the thickness of the fuel cell, and to reduce the overall size of the fuel cell.

[0017]

Preferably, according to the fuel cell recited in claim 3 of the present invention, the first electrically conductive film is made of metal, and the second electrically conductive film is made of composite material of resin and electrically conductive material. It is also preferable for the fuel cell recited in claim 4 of the present invention that the first electrically conductive film is made of composite material of resin and electrically conductive material, and the second electrically conductive film is made of metal.

[0018]

The metal film can be handled easily, and the film of composite material does not require positioning accuracy. Thus, the production of the fuel cell can be carried out simply and easily, and the fuel cell has the simple and compact structure. The anode and the cathode can be positioned upside down such that the cathode faces the porous insulating film. Therefore, the structure of the fuel cell can be changed flexibly depending on the application.

[0019]

According to a method of producing a fuel cell recited in claim 5 of the present invention, a first electrically

conductive film is attached on a porous electrically conductive film. Then, a first electrode (e.g., an anode) of the first power generation unit and a first electrode of the second power generation unit are provided on the first electrically conductive film. The first electrode of the second power generation unit is electrically connected to the first electrically conductive film.

[0020]

Next, a first electrolyte is provided on the first electrode of the first power generation unit and a second electrolyte is provided on the first electrode the second power generation unit such that the first and second electrolytes are partially overlapped on the first electrically conductive film. Then, the other electrode (e.g., a cathode) of the first power generation unit and the other electrode of the second power generation unit are provided on the first and second electrolytes, respectively. The second electrode of the first power generation unit is electrically connected to the first electrically conductive film through the second electrically conductive film. A resin insulator is provided on the second electrically conductive film, and in a gap between the second electrically conductive film and the second electrode.

[0021]

Components of the fuel cells are formed successively on the porous resin film. Thus, the production of the fuel cell is carried out simply. The porous resin film is used

as a base surface for producing the fuel cell. Therefore, the power generation units are positioned accurately. Since the interfaces over the base surface are sealed, it is not required to provide seals which extend through the fuel cell in the stacking direction. The desired sealing performance can be achieved reliably.

[0022]

Preferably, in the fuel cell recited in claim 6 of the present invention, a gas diffusion layer of the first electrode of the second power generation unit and the first electrically conductive film are connected electrically and a gas diffusion layer of the other electrode of the first power generation unit and the second electrically conductive film are connected electrically. With the compact structure, the other electrode of the first power generation unit and the one electrode of the second power generation unit are connected electrically.

[0023]

[MODE FOR CARRYING OUT THE INVENTION]

FIG. 1 is an exploded perspective view showing main components of a fuel cell 10 according to a first embodiment of the present invention. FIG. 2 is a cross sectional view showing main components of the fuel cell 10.

[0024]

The fuel cell 10 includes an MEA (membrane electrode assembly) unit 12, and first and second separators 14, 16 provided on both surfaces of the MEA unit 12.

[0025]

At a corner of the fuel cell 10 in directions indicated by arrows B and C, a fuel gas supply passage 18a for supplying a fuel gas such as a hydrogen-containing gas, and an oxygen-containing gas supply passage 20a for supplying an oxygen-containing gas are formed adjacent to each other. The fuel gas supply passage 18a and the oxygen-containing gas supply passage 20a extend through the fuel cell 10 in a direction indicated by an arrow A. Further, at another corner of the fuel cell 10 in the directions indicated by the arrows B and C, a fuel gas discharge passage 18b for discharging the fuel gas, and an oxygen-containing gas discharge passage 20b for discharging the oxygen-containing gas are formed adjacent to each other. The fuel gas discharge passage 18b and the oxygen-containing gas discharge passage 20b extend through the fuel cell 10 in the direction indicated by the arrow A.

[0026]

The MEA unit 12 includes a porous resin film (porous insulating film) 22. A predetermined number of membrane electrode assemblies (power generation units) 24(1) through 24(n) are arranged in the plane of the porous resin film 22.

[0027]

As shown in FIG. 3, a film such as a silicon film 26 is laminated on the porous resin film 22. The silicon film 26 is like a window frame having windows at positions corresponding to the electrodes of the MEA unit 12 as

described later. The porous resin film 22 has a plurality of holes 27 at predetermined positions (see FIG. 1).

[0028]

As shown in FIGS. 3 and 4, the membrane electrode assembly 24(1) includes an anode 28, a cathode 30, and a polymer electrolyte membrane 29 interposed between the anode 28 and the cathode 30. The anode 28 includes an electrically conductive anode diffusion layer 28a and an anode catalyst layer 28b. The cathode 30 includes an electrically conductive cathode diffusion layer 30a and a cathode catalyst layer 30b.

[0029]

An end 29a of the polymer electrolyte membrane 29 protrudes toward the membrane electrode assembly 24(2) positioned next to the membrane electrode assembly 24(1). The end 29a is stacked on one end of a metal film (first electrically conductive film) 32, and the metal film 32 is laminated on the silicon film 26 on the porous resin film 22.

[0030]

The other end of the metal film 32 is positioned adjacent to the anode 28 of the membrane electrode assembly 24(2). An end 28aa of the anode diffusion layer 28a of the anode 28 protrudes toward the membrane electrode assembly 24(1). The end 28aa is stacked on the other end the metal film 32. An end 29b of the polymer electrolyte membrane 29 of the membrane electrode assembly 24(2) protrudes toward

the membrane electrode assembly 24(1), and the end 29b covers the end 28aa of the anode diffusion layer 28a, and a predetermined area of the metal film 32. A circular gap 34a is formed between the ends 29a, 29b of the pair of the adjacent polymer electrolyte membranes 29.

[0031]

An end of an electrically conductive member (second electrically conductive film) 36 is electrically connected to the cathode diffusion layer 30a of the cathode 30 of the membrane electrode assembly 24(1). The electrically conductive member 36 is made of composite material of resin and electrically conductive material, e.g., carbon. The electrically conductive member 36 is disposed between the membrane electrode assemblies 24(1), 24(2). A gap 34b is formed between the electrically conductive member 36 and the cathode 30 of the membrane electrode assembly 24(2). The electrically conductive member 36 includes a columnar expansion 36a protruding toward the gap 34a between the ends 29a, 29b of the polymer electrolyte membranes 29.

[0032]

The expansion 36a is electrically connected to the metal film 32. Thus, the cathode 30 of the membrane electrode assembly 24(1) and the anode 28 of the membrane electrode assembly 24(2) are electrically connected with each other. A resin insulator 38 covers the electrically conductive member 36, and seals the gap 24b between the electrically conductive member 36 and the cathode 30 of the

membrane electrode assembly 24(2).

[0033]

The first and second separators 14, 16 are made of insulating, and thermally conductive material such as reinforced plastic. As shown in FIGS. 1 and 5, the first separator 14 has a supply manifold 40 and a discharge manifold 42 on its surface 14a facing the MEA unit 12. The supply manifold 40 is formed on one side in the direction indicated by the arrow C, and the discharge manifold 42 is formed on the other side in the direction indicated by the arrow C. The supply manifold 40 and the discharge manifold 42 extend in the direction indicated by the arrow B. The supply manifold 40 includes a groove connected to the fuel gas supply passage 18a. The discharge manifold 42 includes a groove connected to the fuel gas discharge passage 18b.

[0034]

A fuel gas flow field 44 is formed between the supply manifold 40 and the discharge manifold 42 for supplying the fuel gas to the anodes 28 of the MEA unit 12. The fuel gas flow field 44 includes a plurality of flow grooves extending in the direction indicated by the arrow C between the supply manifold 40 and the discharge manifold 42. Rectangular recesses 46 for providing the anodes 28 of the membrane electrode assemblies 24(1) through 24(n) are formed on the surface 14a. Further, a plurality of threaded holes 48 are formed at predetermined positions on the surface 14a.

[0035]

A seal 50 is formed around the fuel gas supply passage 18a, the fuel gas discharge passage 18b, the supply manifold 40, the discharge manifold 42, and the fuel gas flow field 44 by heat treatment, for example. The first separator 14 has a negative terminal 52 which is connectable to the anode 28 of the membrane electrode assembly 24(1).

[0036]

As shown in FIG. 6, the second separator 16 has a supply manifold 54 and a discharge manifold 56 on its surface 16a facing the MEA unit 12. The supply manifold 54 is connected to the oxygen-containing gas supply passage 20a, and extends in the direction indicated by the arrow B. The discharge manifold 56 is connected to the oxygen-containing gas discharge passage 20b, and extends in the direction indicated by the arrow B. The supply manifold 54 and the discharge manifold 56 are connected by an oxygen-containing gas flow field 58. The oxygen-containing gas flow field 58 includes a plurality of flow grooves extending in the direction indicated by the arrow C.

[0037]

A seal 50 is formed around the oxygen-containing gas supply passage 20a, the oxygen-containing gas discharge passage 20b, the supply manifold 54, the discharge manifold 56, and the oxygen-containing gas flow field 58 by heat treatment, for example.

[0038]

Rectangular recesses 60 corresponding to the cathodes

30 of the membrane electrode assemblies 24(1) through 24 (n) are formed on the surface 16a. Seal-attached Holes 62 are formed at predetermined positions on the surface 16a. As shown in FIG. 1, tightening screws 64 are inserted through the seal-attached holes 62, and the holes 27 of the MEA unit 12, and screwed into the seal-attached threaded holes 48 of the first separator 14 for tightening the components of the fuel cell 10 together. The second separator 16 has a positive terminal 66 which is connectable to the cathode 30 of the membrane electrode assembly 24(n).

[0039]

As shown in FIG. 1, the second separator 16 has ribs 70 extending in the direction indicated by the arrow C on its surface 16b opposite to the surface 16a. A coolant flow field is formed on the surface 16b by guide grooves 72 defined between the ribs 70.

[0040]

Next, operation of producing the fuel cell 10 will be described.

[0041]

In particular, operation of producing a pair of the adjacent membrane electrode assemblies 24(1), 24(2) will be described in detail. Operation of producing the other membrane electrode assemblies 24(3) through 24(n) will not be described.

[0042]

Firstly, the porous resin film 22 as a base plane of

the entire MEA unit 12 is produced. Next, the silicon film 26 having windows corresponding to the membrane electrode assemblies 24(1) through 24(n) are laminated on the porous resin film 22.

[0043]

Then, as shown in FIG. 7, adhesive 80 is applied on the porous resin film 22. The adhesive 80 is used for attaching the metal film 32 to the silicon film 26. The anode diffusion layer 28a of, e.g., carbon and resin is formed on the porous resin film 22 using a masking member 82. Then, the anode diffusion layer 28a is dried. The end 28aa of the anode diffusion layer 28a of the membrane electrode assembly 24(2) is stacked on the metal film 32, and thus, electrically connected to the metal film 32.

[0044]

Next, as shown in FIG. 8, a masking member 84 is placed on the metal film 32. The anode catalyst layer 28b is formed on the anode diffusion layer 28a using the masking member 84. Then, the anode catalyst layer 28b is dried.

[0045]

Thereafter, as shown in FIG. 9, the polymer electrolyte membrane 29 is formed by coating using the masking member (e.g., screen) 86. Specifically, in the membrane electrode assembly 24(1), the masking member 86 is disposed at a position for forming the gap 34a, and the end 29a of the polymer electrolyte membrane 29 on the anode electrolyte layer 28b extends over one end of the metal film 32. In the

membrane electrode assembly 24(2), the end 29b of the polymer electrolyte membrane 29 extends from the electrolyte catalyst layer 28b over other end of the metal film 32. Thus, the circular gap 34a is formed by the masking member 86 between the ends 29a, 29b.

[0046]

After the polymer electrolyte membrane 29 is dried, as shown in FIG. 10, the cathode catalyst layer 30b is formed on the polymer electrolyte membrane 29 using the masking member 84. After the cathode electrolyte layer 30b is dried, the cathode diffusion layer (e.g., carbon and resin) 30a is formed on the cathode electrolyte layer 30b. Then, the cathode diffusion layer 30a is dried.

[0047]

Thereafter, as shown in FIG. 11, the electrically conductive member 36 is formed using the masking member 88, and the electrically conductive member 36 is dried. The electrically conductive member 36 is electrically connected to the cathode diffusion layer 30a of the cathode 30 of the membrane electrode assembly 24(1). The columnar expansion 36a of the electrically conductive member 36 is inserted into the circular gap 34a formed between the ends 29a, 29b of the polymer electrolyte membrane 29. The expansion 36a is electrically connected to the metal film 32. In this manner, the cathode 30 of the membrane electrode assembly 24(1) and the anode 28 of the membrane electrode assembly 24(2) are electrically connected through the electrically

conductive member 36 and the metal film 32.

[0048]

After the electrically conductive member 36 is dried, as shown in FIG. 12, the resin insulator 38 is formed using the masking member 90. The resin insulator 38 is filled in the gap 34b between the electrically conductive member 36 and the cathode 30 of the membrane electrode assembly 24(2). In this manner, the cathode 30 of the membrane electrode assembly 24(1) and the cathode 30 of the membrane electrode assembly 24(2) are insulated from each other. The pair of the adjacent membrane electrode assemblies 24(1), 24(2) are electrically connected in series on the porous resin film 22.

[0049]

As shown in FIG. 13, an electrical contact 92a is provided between an end of the cathode 30 of the membrane electrode assembly 24(1) and an end of the electrically conductive member 36. An electrical contact 92b is provided at an interface between an end surface of the columnar expansion 36a of the electrically conductive member 36 and the metal film 32. Further, an electrical contact 92c is provided at an interface between the metal film 32 and the end 28aa of the anode diffusion layer 28a of the membrane electrode assembly 24(2).

[0050]

In the first embodiment, as shown in FIG. 3, the cathode 30 of the membrane electrode assembly 24(1) and the

anode 28 of the membrane electrode assembly 24(2) are electrically connected in series by the metal film 32 and the electrically conductive member 36. Thus, unlike the conventional structure, no dedicated Z-like connection plates are required for electrical connection. The electrical connection between the electrodes can be carried out with the simple and economical structure. The overall size of the fuel cell 10 is small, and the overall structure of the fuel cell 10 is simple.

[0051]

The metal film 32 can be handled easily at the time of producing the fuel cell 10. Since high accuracy is not required in positioning the electrically conductive member 36, the fuel cell 10 of the simple and small structure can be produced easily, and simply. In particular, the metal film 32 and the electrically conductive member 36 are positioned substantially in the same plane as the anode 28 and the cathode 30. The MEA unit 12 is thin, and the overall size of the fuel cell 10 is small.

[0052]

In the sealing structure for preventing leakage of the fuel gas and the oxygen-containing gas, the interface having the distance of H1 (the interface between the end 29a of the polymer electrolyte membrane 29, and the silicon film 26 and the metal film 32) and the interface having the distance H2 (the interface between the end 29b of the polymer electrolyte membrane 29, and the metal film 32 and the end

28aa of the anode diffusion layer 28a) are sealed effectively. Thus, the reliability of the sealing structure for preventing leakage of the reactant gases is high.

[0053]

In the first embodiment, components of the MEA unit 12 are formed on the porous resin film 22 successively. Thus, the production of the fuel cell 10 is carried out simply. The porous resin film 22 is used as a base planar surface for producing the fuel cell 10. Therefore, the membrane electrode assemblies 24(1) through 24(n) are positioned accurately, and the production of the fuel cell 10 is carried out simply.

[0054]

Next, operation of the fuel cell 10 will be described.

[0055]

Firstly, referring to FIG. 1, an oxygen-containing gas is supplied to the oxygen-containing gas supply passage 20a and a fuel gas such as a hydrogen containing gas is supplied to the fuel gas supply passage 18a. Further, a coolant such as pure water, an ethylene glycol or an oil is supplied to the coolant flow fields 72.

[0056]

Specifically, as shown in FIG. 6, the oxygen-containing gas flows into the supply manifold 54 on the surface 16a of the second separator 16. Then, the oxygen-containing gas is supplied into the oxygen-containing gas flow field 58. The oxygen-containing gas flows through the flow grooves of the

oxygen-containing gas flow field 58 in the direction indicated by the arrow C along the cathodes 30 of the membrane electrode assemblies 24(1) through 24(n) for inducing a chemical reaction at the cathodes 30. After the oxygen in the oxygen-containing gas is partially consumed, the oxygen-containing gas is discharged into the oxygen-containing gas discharge passage 20b through the discharge manifold 56.

[0057]

Likewise, as shown in FIG. 5, the fuel gas flows into the fuel gas manifold 40 on the surface 14a of the first separator 14. Then, the fuel gas is supplied into the fuel gas flow field 44 connected to the supply manifold 40. The fuel gas flows through the flow grooves of the fuel gas flow field 44 in the direction indicated by the arrow C along the anodes 28 of the membrane electrode assemblies 24(1) through 24(n) for inducing a chemical reaction at the anodes 28.

[0058]

Thus, in the membrane electrode assemblies 24(1) through 24(n), the oxygen-containing gas supplied to the cathodes 30, and the fuel gas supplied to the anodes 28 are consumed in the electrochemical reactions at catalyst layers of the cathodes 30 and the anodes 28 for generating electricity. All of the power generation units, i.e., the membrane electrode assemblies 24(1) through 24(n) are electrically connected in series between the terminals 52 and 66 for outputting a desired level of voltage.

[0059]

FIG. 14 is a view showing connection state in an MEA unit 100 of a fuel cell according to a second embodiment of the present invention. The constituent elements that are identical to those of the MEA unit 12 of the fuel cell 10 according to the first embodiment are labeled with the same reference numeral, and description thereof will be omitted. Likewise, in the third embodiment as described later, the constituent elements that are identical to those of the MEA unit 12 of the fuel cell 10 according to the first embodiment are labeled with the same reference numeral, and description thereof will be omitted.

[0060]

The membrane electrode assembly 102(1) of the MEA unit 100 includes a cathode 30 formed on a porous resin film 22, and an anode 28, and a polymer electrolyte membrane 29 interposed between the cathode 30 and the anode 28.

[0061]

The membrane electrode assembly 102(2) adjacent to the membrane electrode assembly 102(1) has an end 30aa extending from the cathode diffusion layer 30a toward the membrane electrode assembly 102(1), and the end 30aa is stacked on the metal film (second electrically conductive film) 32. An end of the electrically conductive member (first electrically conductive film) 36 is electrically connected to the anode diffusion layer 28a of the anode 28 of the membrane electrode assembly 102(1).

[0062]

In the second embodiment, the cathode 30 is disposed on the lower side, and the anode 28 is disposed on the upper side, on the porous resin film 22, i.e., the cathode 30 and the anode 28 are disposed upside-down in contrast to the first embodiment. The advantages of the first embodiment can be obtained in the second embodiment.

[0063]

[EFFECT OF THE INVENTION]

According to the fuel cell of the present invention, unlike the conventional structure, no dedicated Z-like connection plates are required. The reliable sealing performance can be achieved with the simple and economical structure. The overall size of the fuel cell is small, and the overall structure of the fuel cell is simple.

[0064]

According to the method of producing the fuel cell of the present invention, components of the fuel cells are formed successively on the porous resin film. Thus, the production of the fuel cell is carried out simply. The porous resin film is used as a base surface for producing the fuel cell. Therefore, the power generation units are positioned accurately. Since the interfaces over the base surface are sealed, it is not required to provide seals which extend through the fuel cell in the stacking direction. The desired sealing performance can be achieved reliably.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[FIG. 1]

FIG. 1 is an exploded perspective view showing main components of a fuel cell according to a first embodiment of the present invention.

[FIG. 2]

FIG. 2 is a cross sectional view showing main components of the fuel cell.

[FIG. 3]

FIG. 3 is a view showing connection state in an MEA unit of the fuel cell.

[FIG. 4]

FIG. 4 is a front view showing the MEA unit.

[FIG. 5]

FIG. 5 is a front view showing a first separator of the fuel cell.

[FIG. 6]

FIG. 6 is a front view showing a second separator of the fuel cell.

[FIG. 7]

FIG. 7 is a view showing an anode diffusion layer formed on a porous resin film of the fuel cell.

[FIG. 8]

FIG. 8 is a view showing an anode catalyst layer formed on the anode diffusion layer of the fuel cell.

[FIG. 9]

FIG. 9 is a view showing a process of forming a polymer electrolyte membrane of the fuel cell.

[FIG. 10]

FIG. 10 is a view showing a process of forming a cathode electrolyte layer and a cathode diffusion layer of the fuel cell.

[FIG. 11]

FIG. 11 is a view showing a process of forming an electrically conductive member of the fuel cell.

[FIG. 12]

FIG. 12 is a view showing a process of forming a resin insulator in the fuel cell.

[FIG. 13]

FIG. 13 is a perspective view of electrical contacts of the fuel cell.

[FIG. 14]

FIG. 14 a view showing connection state in an MEA unit of a fuel cell according to a second embodiment of the present invention.

[FIG. 15]

FIG. 15 is a cross sectional view showing main components of a flat fuel cell disclosed in Patent Document 1.

[DESCRIPTION OF REFERENCE NUMERALS]

10: fuel cell, 12, 100: MEA unit, 14, 16: separator,

18a: fuel gas supply passage,

18b: fuel gas discharge passage,

20a: oxygen-containing gas supply passage,

20b: oxygen-containing gas discharge passage

22: porous resin film,

24(1) to 24(n), 102(1), 102(2): membrane electrode assemblies,

26: silicon film, 28: anode, 28a: anode diffusion layer,

28aa, 29a, 29b, 30aa: end, 28b: anode catalyst layer,

29: polymer electrolyte membrane, 30: cathode,

30a: cathode diffusion layer, 30b: cathode catalyst layer,

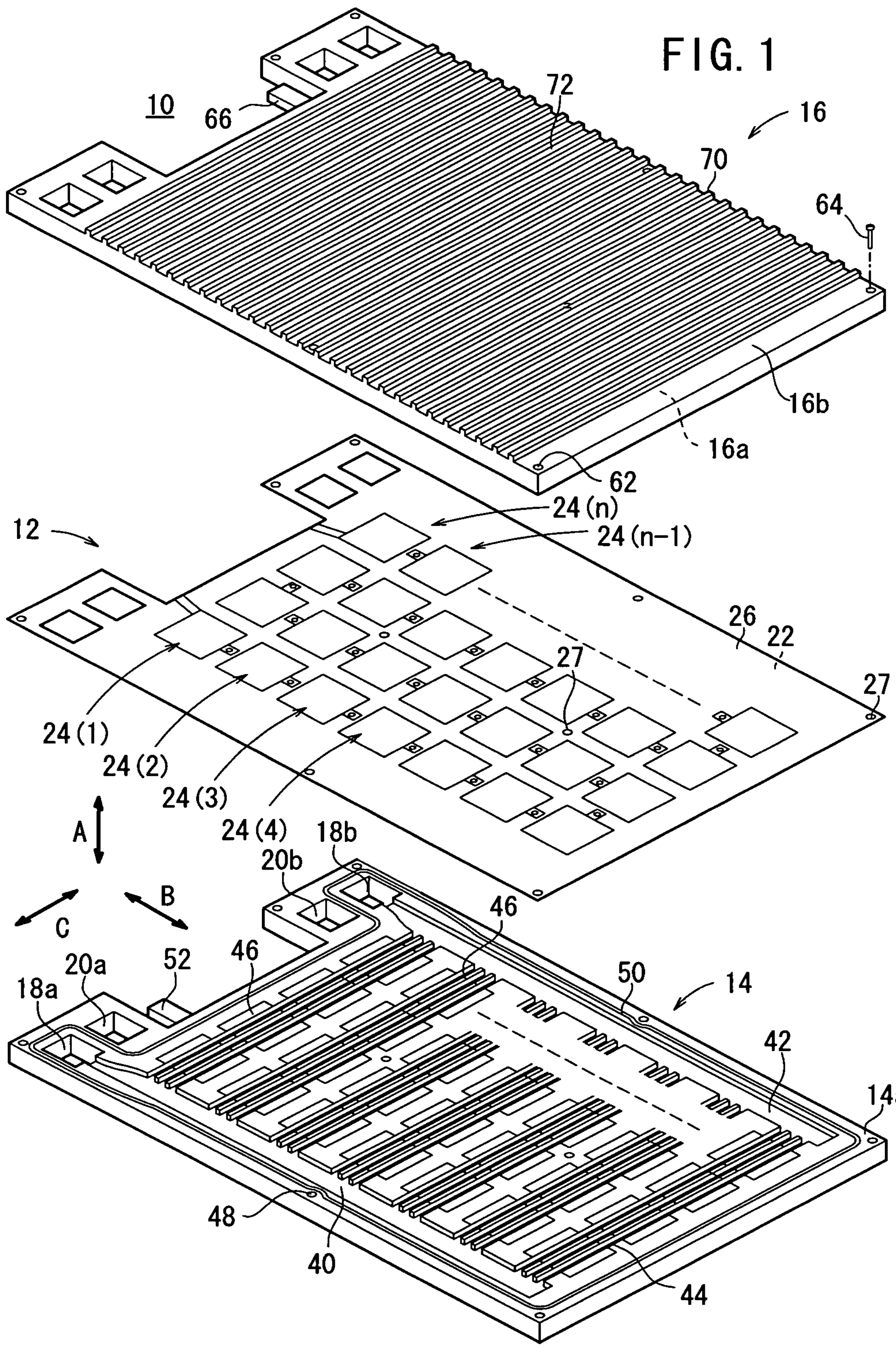
32: metal film, 34a, 34b: gap,

36: electrically conductive member, 36a: expansion,

38: resin insulator, 44: fuel gas flow field,

58: oxygen-containing gas flow field

FIG. 1



10
66
72
16
70
64
16b
16a
62
12
24 (n)
24 (n−1)
26
22
27
27
24 (1)
24 (2)
24 (3)
24 (4)
A
B
C
18b
20b
46
46
20a
52
18a
50
14
42
14a
48
40
44

FIG. 2

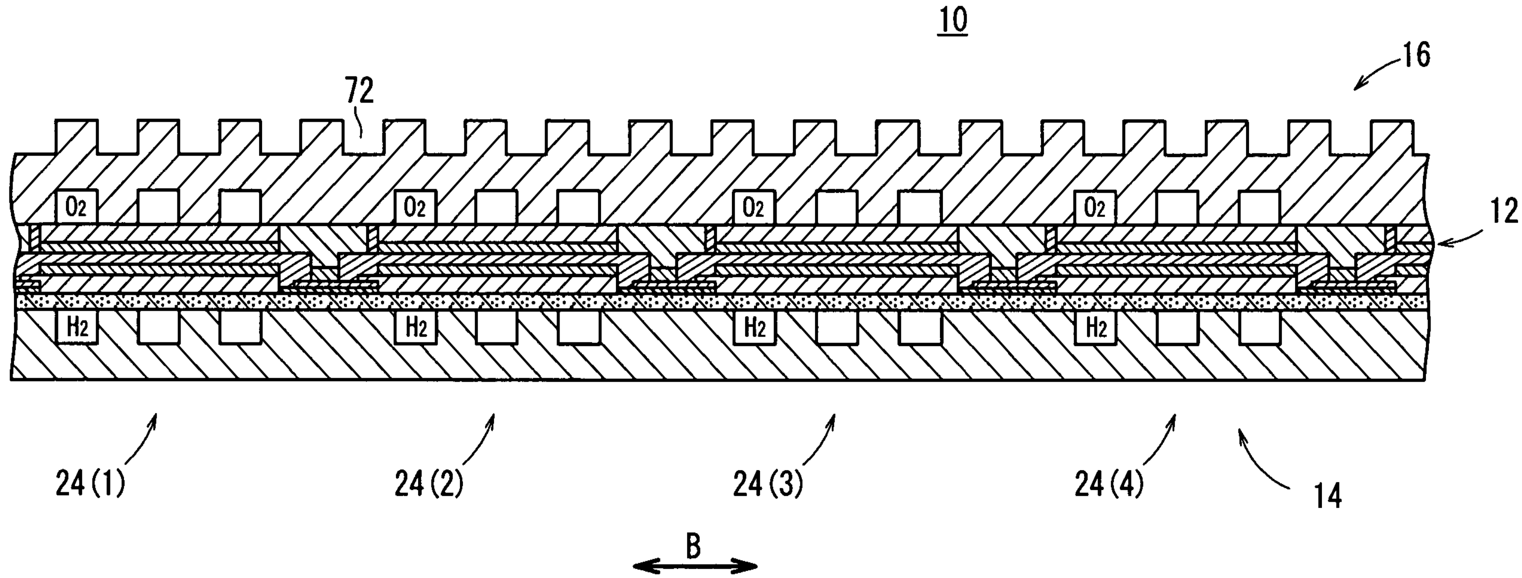
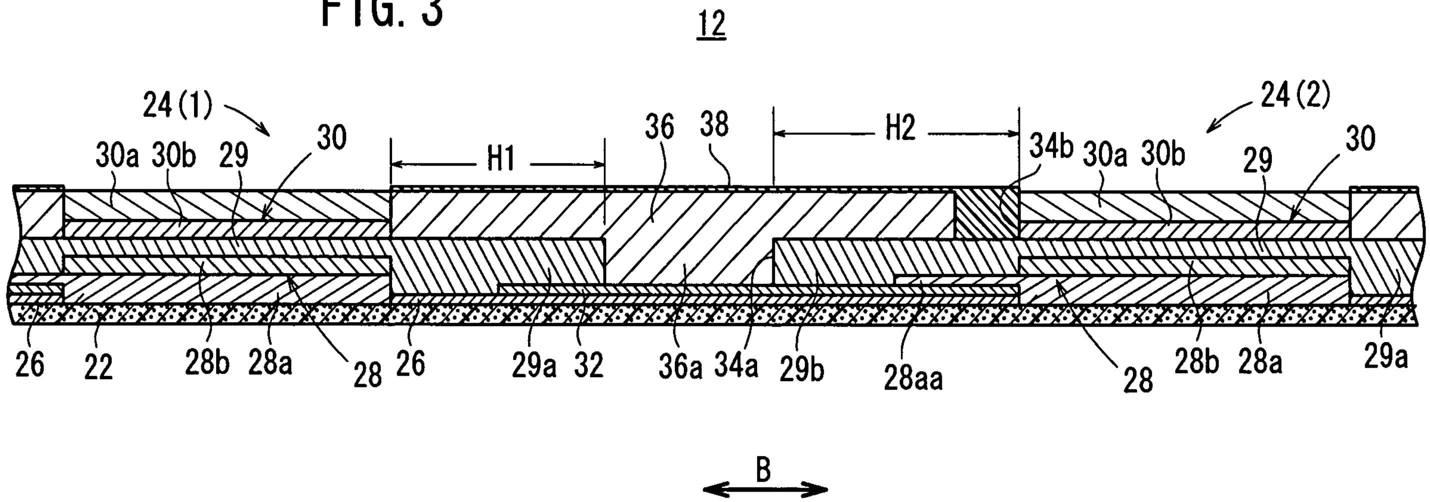
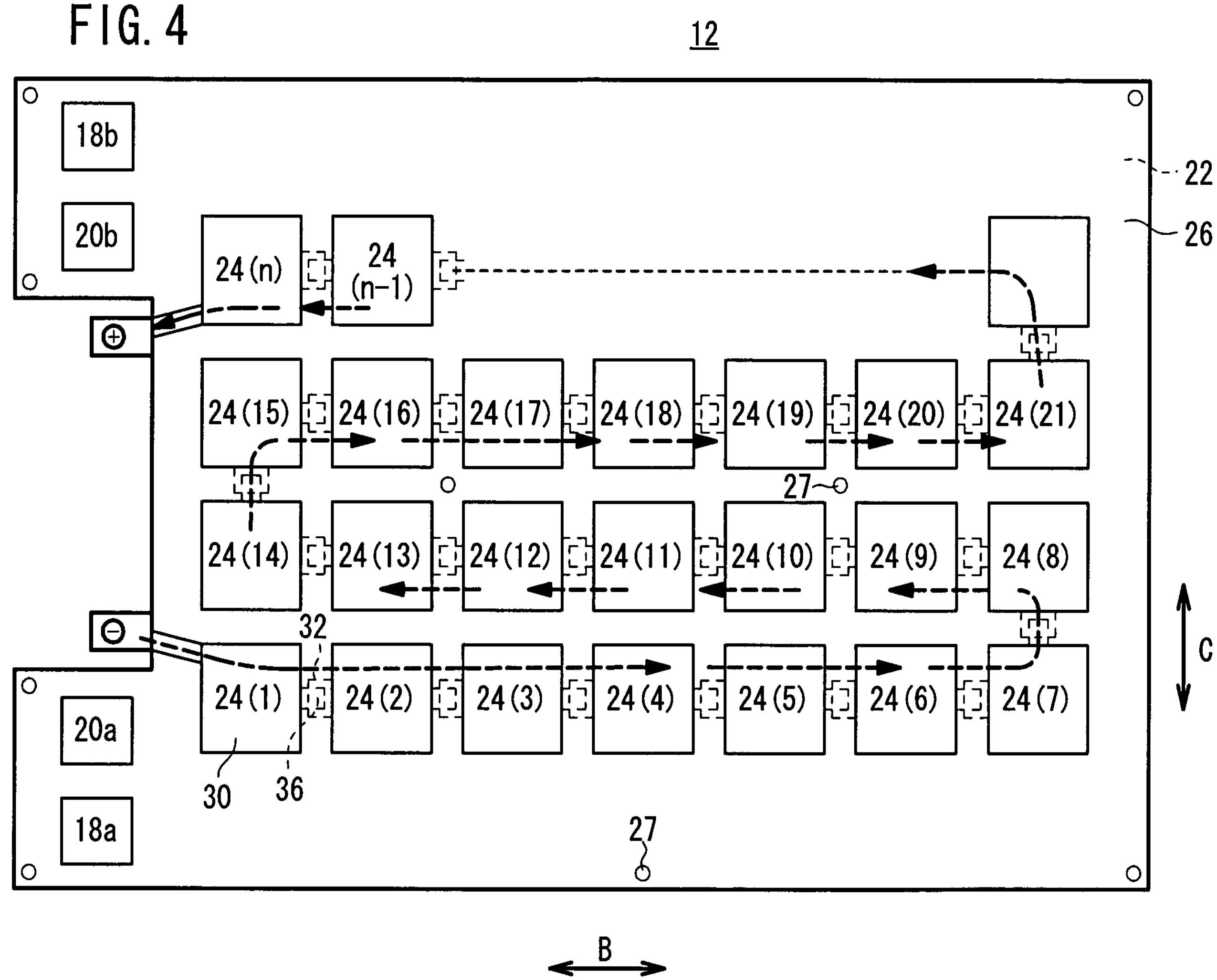


FIG. 3



12
24(1)
30a 30b 29
30
H1
36 38
H2
34b 30a 30b
24(2)
29
30
26
22
28b 28a
28
26
29a 32
36a 34a 29b
28aa
28
28b 28a
29a
B

FIG. 4



12
18b
20b
24 (n)
24 (n−1)
22
26
24 (15)
24 (16)
24 (17)
24 (18)
24 (19)
24 (20)
24 (21)
27
24 (14)
24 (13)
24 (12)
24 (11)
24 (10)
24 (9)
24 (8)
32
24 (1)
24 (2)
24 (3)
24 (4)
24 (5)
24 (6)
24 (7)
C
20a
18a
30
36
27
B

FIG. 5

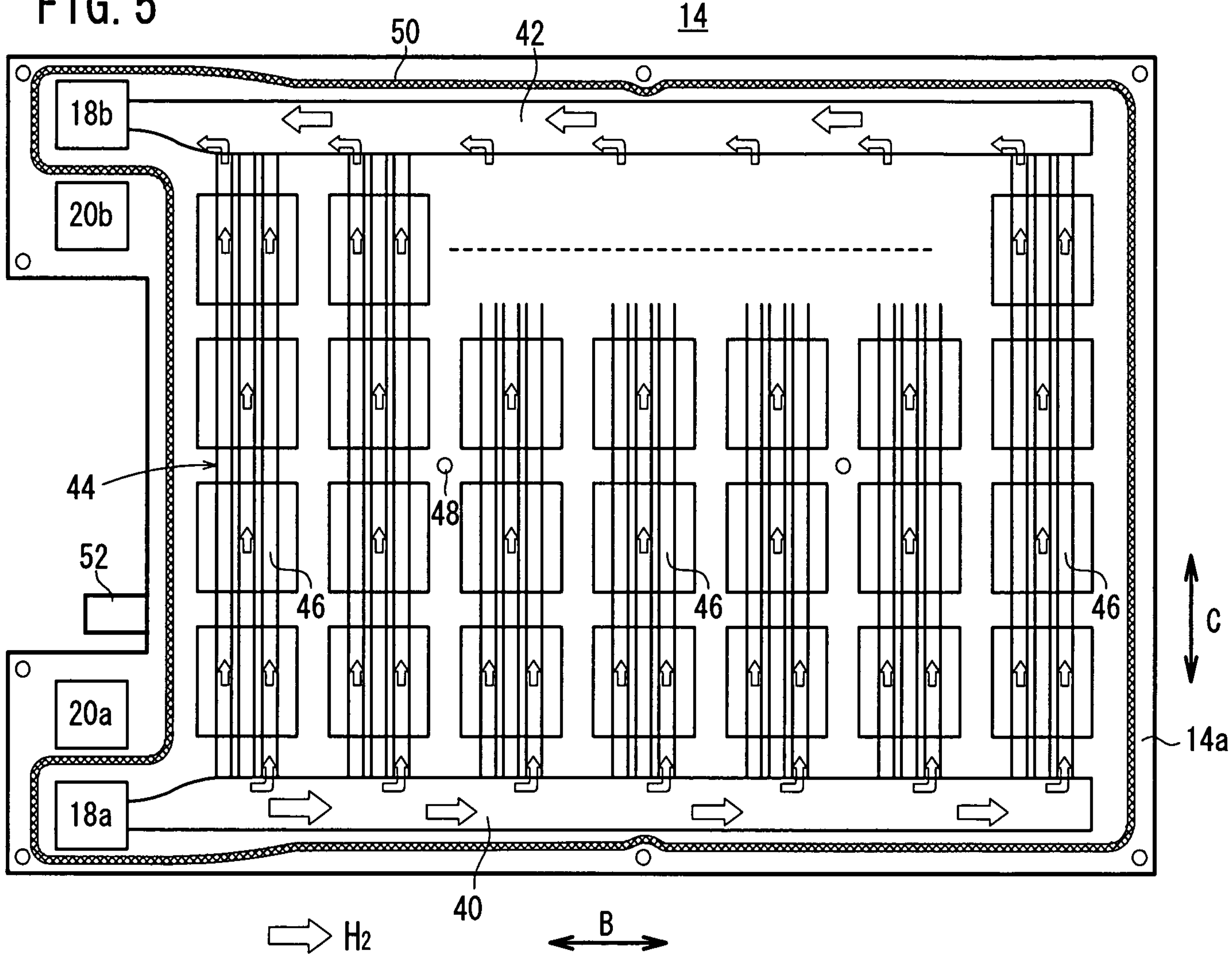


FIG. 6

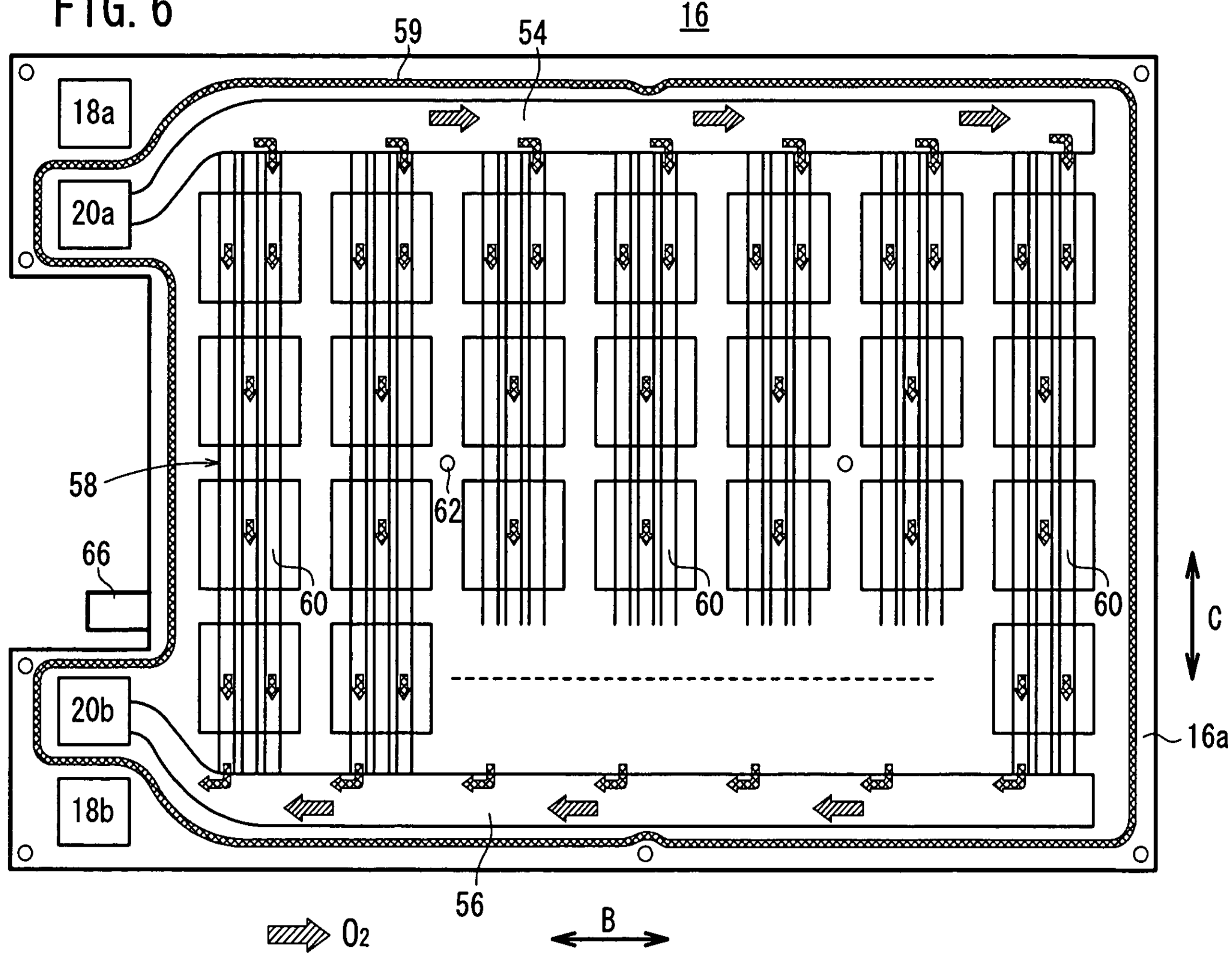


FIG. 7

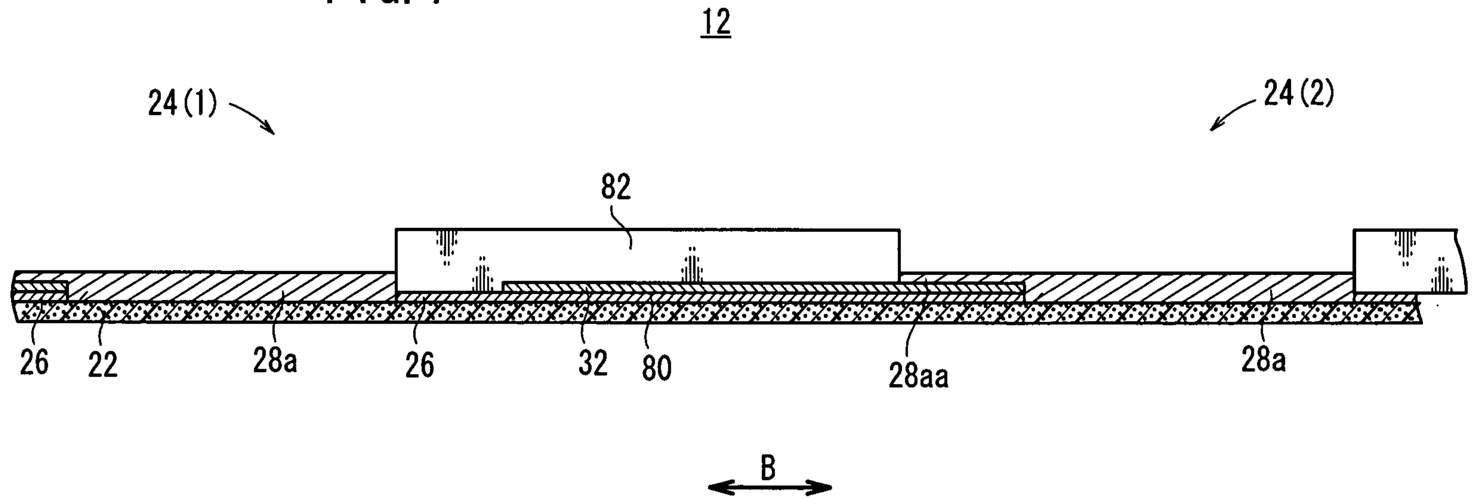


FIG. 8

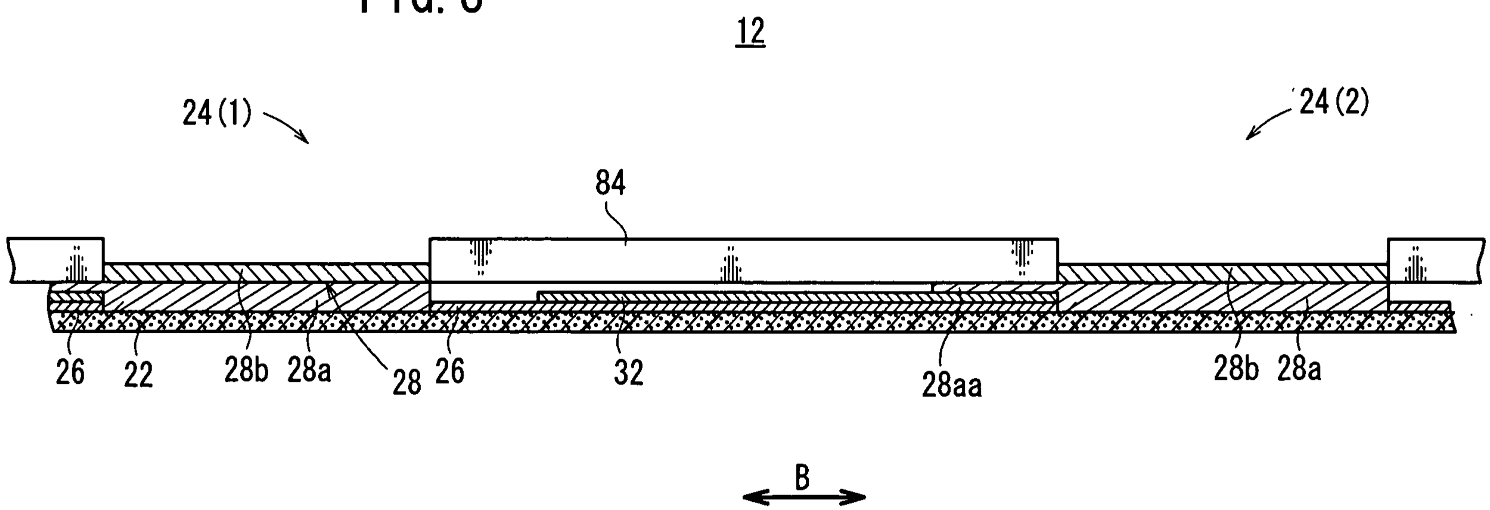
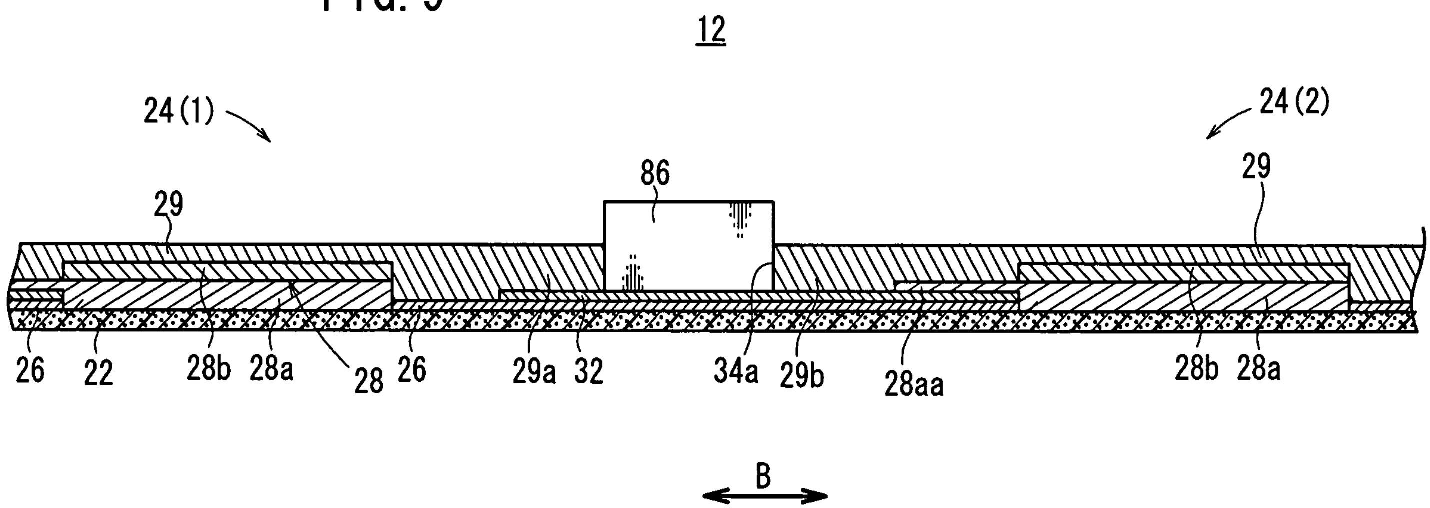
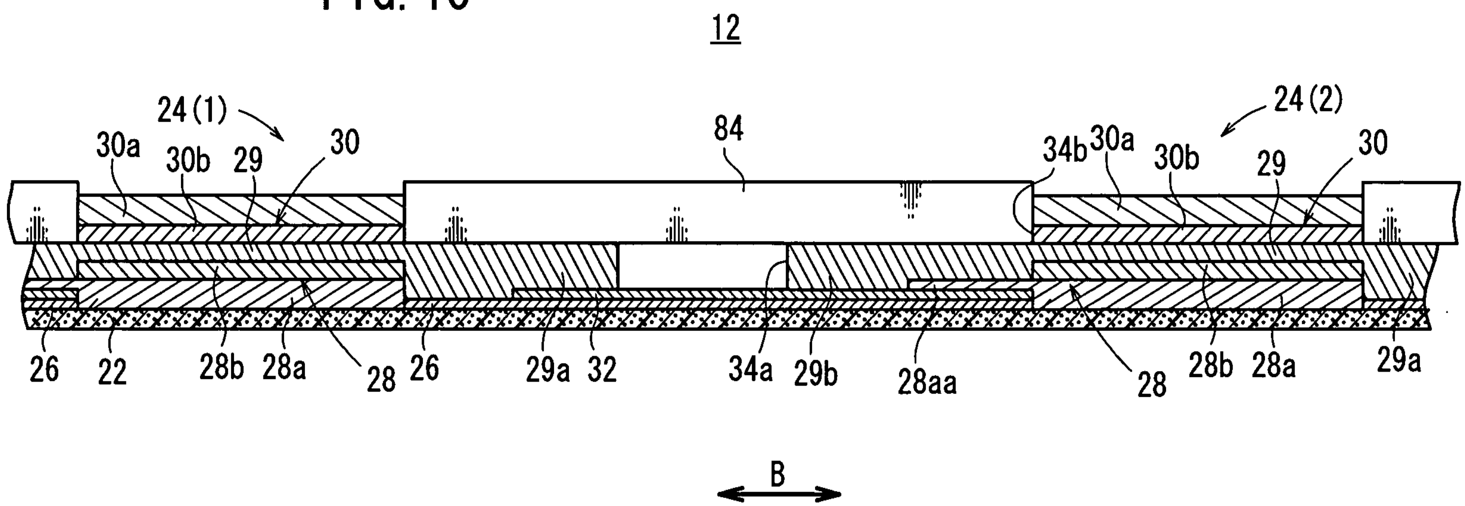


FIG. 9



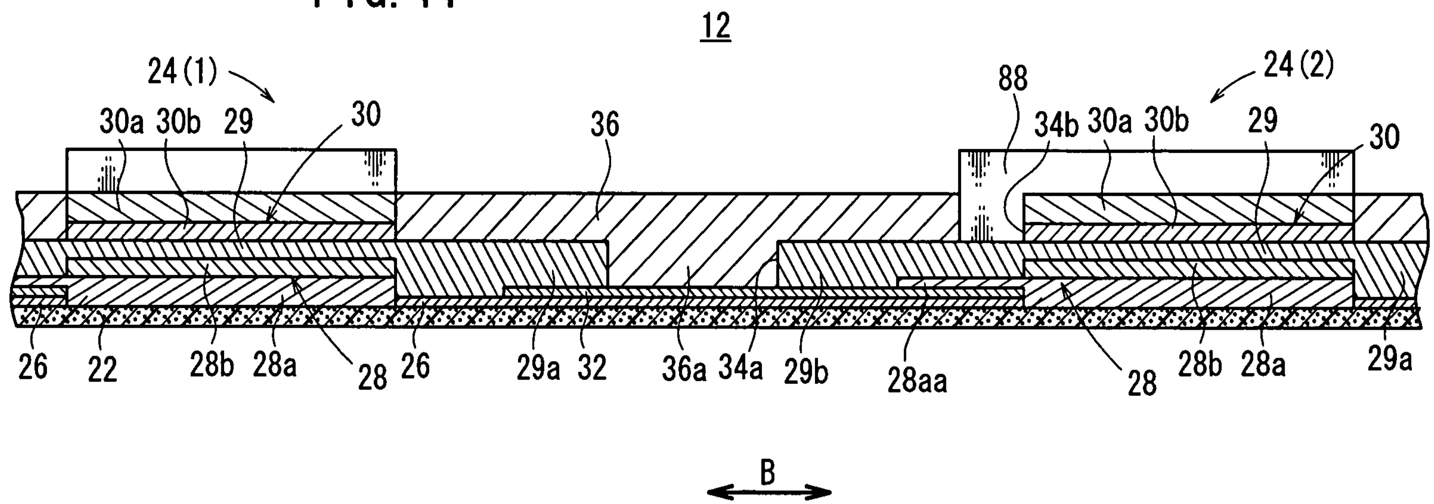
12
24(1)
24(2)
86
29
29
26
22
28b
28a
28
26
29a
32
34a
29b
28aa
28b
28a
B

FIG. 10



12
24 (1)
30a
30b
29
30
84
34b
24 (2)
26
22
28b
28a
28
29a
32
34a
29b
28aa
B

FIG. 11



12
24 (1)
30a 30b 29
30
36
88
24 (2)
34b 30a 30b
29
30
26
22
28b 28a
28
26
29a 32
36a 34a
29b
28aa
28
28b 28a
29a
B

FIG. 12

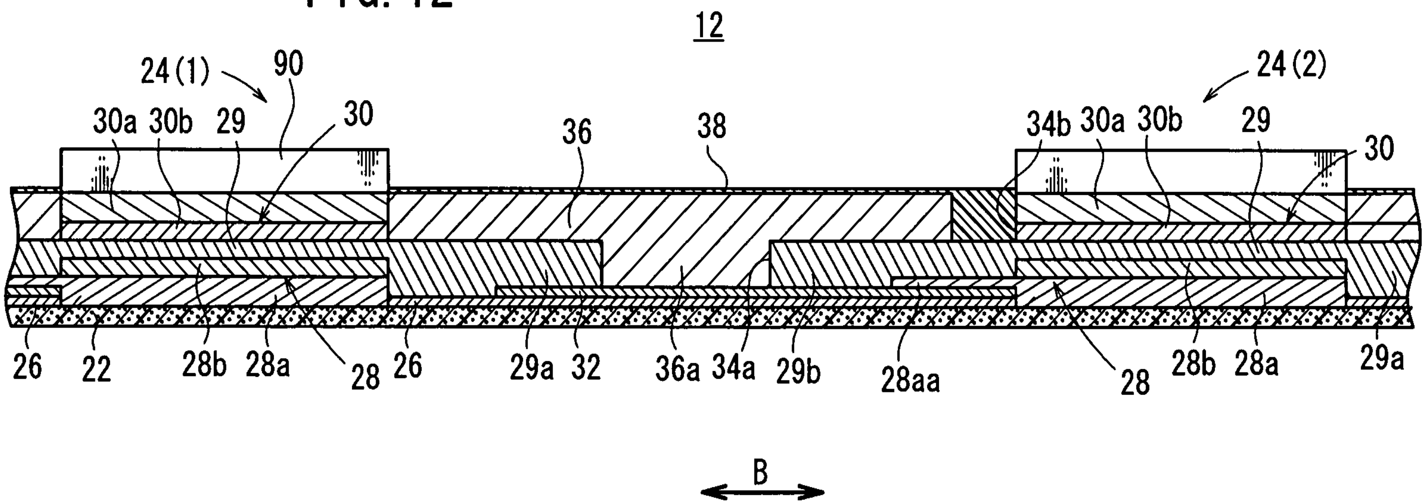

12
24(1)
90
30a 30b 29
30
36
38
34b 30a 30b
24(2)
29
30
26
22
28b 28a
28
26
29a 32
36a 34a 29b
28aa
28
28b 28a
29a
B

FIG. 13

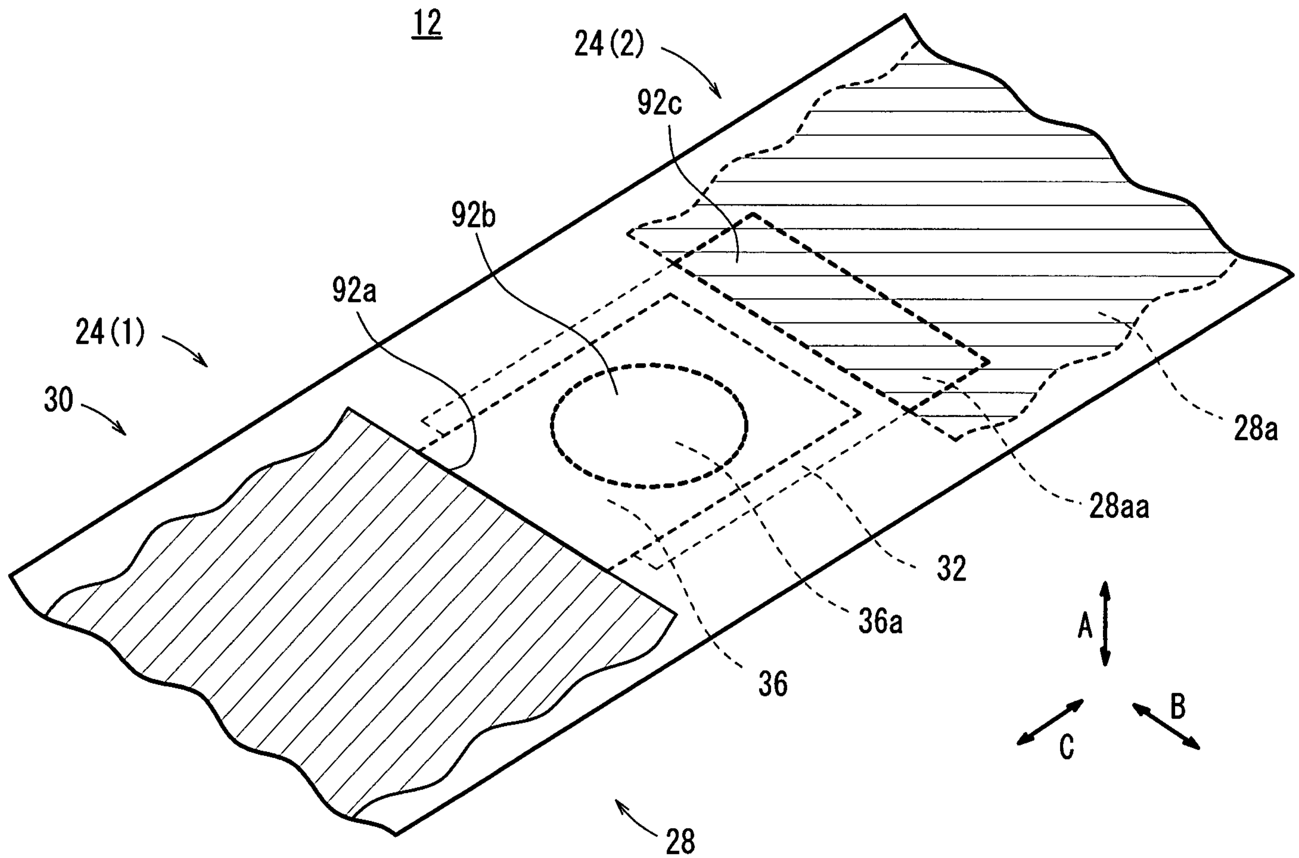
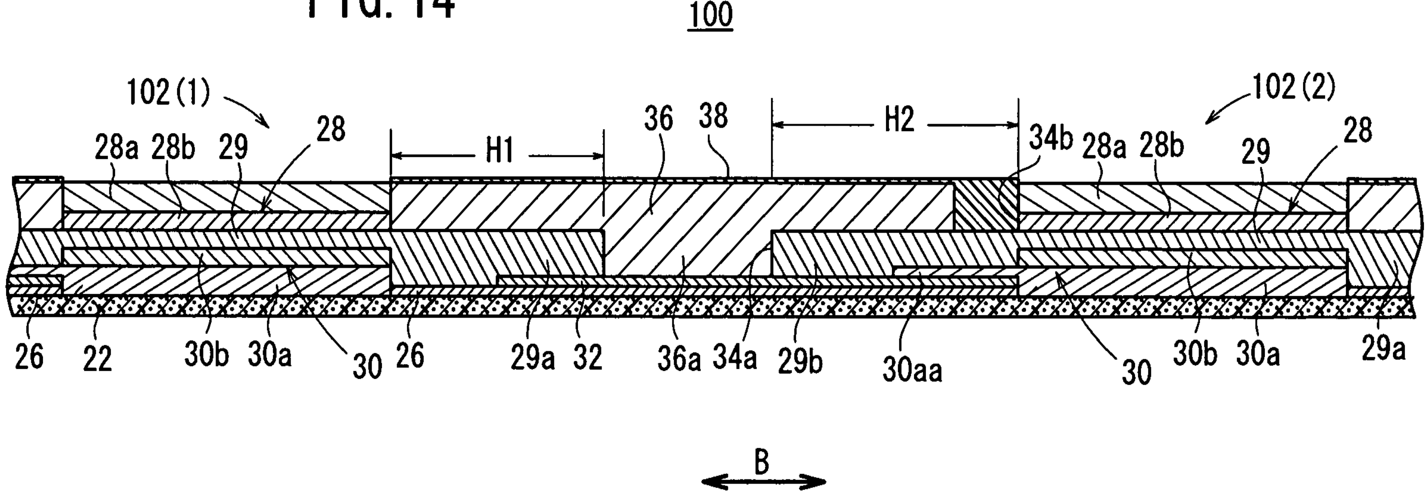
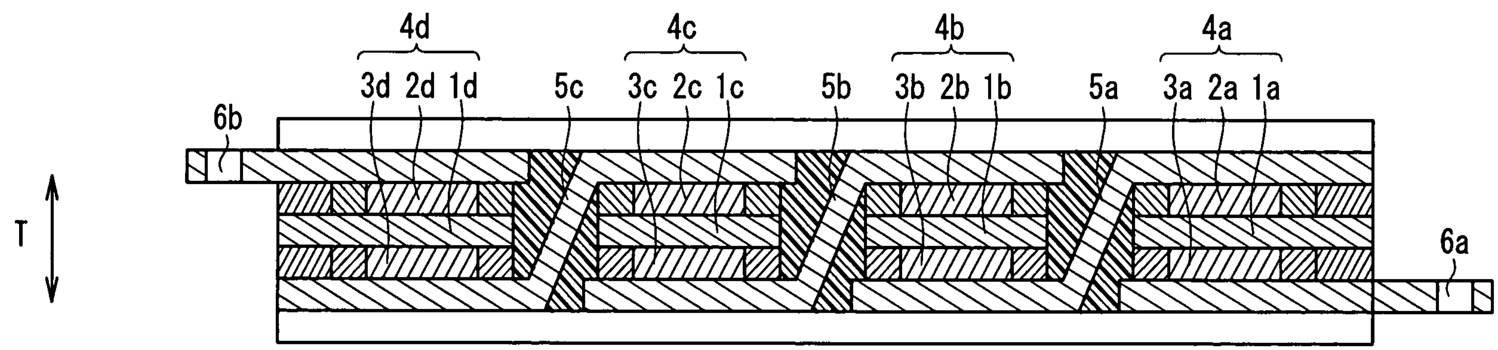


FIG. 14



100
102 (1)
102 (2)
28a
28b
29
28
H1
36
38
H2
34b
26
22
30b
30a
30
29a
32
36a
34a
29b
30aa
B

FIG. 15



[DOCUMENT NAME] Abstract

[ABSTRACT]

[TASK] To improve seal performance with a simple and compact structure while electrically connecting a plurality of power generation units in series.

[SOLUTION] Anodes 28 are provided on a porous resin film (22), a polymer electrolyte membrane 29 is provided on the anodes 28, and cathodes are provided on the polymer electrolyte membrane 29 to form a plurality of membrane electrode assemblies 24 as power generation units.

An electrically conductive member 36 is connected to the cathode 30 of a membrane electrode assembly 24(1), and a metal film 32 is electrically connected to the anode 28 of an adjacent membrane electrode assembly 24(2). The electrically conductive member 36 has an expansion 36a connected to the metal film 32. The cathode 30 of the membrane electrode assembly 24(1) and the anode 28 of the adjacent membrane electrode assembly 24(2) are electrically connected by the electrically conductive member 36 and the metal film 32.

[SELECTED FIGURE] FIG. 3

IN THE MATTER OF
Patent Application of
HONDA MOTOR CO., LTD.

I, Nobuko SUDA, 17-23 Fukasawa 6-chome, Setagaya-ku, Tokyo 158-0081, Japan, do hereby declare that I am conversant with the Japanese and English languages and am a competent translator thereof. I further declare that to the best of my knowledge and belief, the following is a true and correct translation, made by me, of the official copy of the document in respect of a Patent Application No. 2003-062009 filed in Japan on March 7, 2003.

Signed this 3rd day of July, 2007

By N. S. Suda
Nobuko SUDA

(Translation)

JAPAN PATENT OFFICE

This is to certify that the annexed is a true copy of the following application as filed with this Office.

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Application Number: Patent Application No. 2003-062009

Applicant(s): HONDA MOTOR CO., LTD.

December 24, 2003

Commissioner,
Japan Patent Office

Yasuo IMAI (Seal)
(Certificate No. 2003-3106936)

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[To] The Commissioner of the Patent Office

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[Indication of Fees]

[Prepayment Register Number]	001834
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[List of the Attached Documents]

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[Document Name]	Drawings	1
[Document Name]	Abstract	1
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[General Power of Attorney Number]	0206309	

[Proof]	Necessary

(2003-062009)

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[Reason for Change]	New Registration
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